Postpartum Depression and Timing of Spousal Military Deployment Relative to Pregnancy and Delivery

Jordan A. Levine
Anna T. Bukowinski
Carter J. Sevick
Krista M. Mehlhaff
Ava Marie S. Conlin

Naval Health Research Center

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Naval Health Research Center
140 Sylvester Road
San Diego, California 92106-3521

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Abstract
Objective This study aimed to determine the relationship between spousal deployment and postpartum depression diagnosis among U.S. military wives, accounting for the timing of deployment with respect to pregnancy and delivery.
Methods A retrospective cohort study was conducted to evaluate the association between spousal deployment and postpartum depression among pregnant wives of active-duty service members. Electronic medical records for 161,454 births occurring between 2004 and 2009 were used to define postpartum depression. Three non-mutually exclusive exposure variables were created to categorize deployments as occurring before, during, or after the infant's delivery. A multivariable logistic regression model mutually adjusted for these exposure variables was fitted, producing an odds ratio for each of the three timing categories.
Results A modest significant association was detected only in those whose husbands deployed in pregnancy and returned after delivery (i.e., deployed during delivery) [odds ratio (OR) 1.10, 95 % confidence interval (CI) 1.04–1.15]. An interactive effect between preexisting depression or anxiety and deployment during delivery was also detected in the data (OR 1.13, 95 % CI 1.07–1.20 for those without a preexisting diagnosis; OR 0.87, 95 % CI 0.80–0.95 for those with a preexisting diagnosis).
Conclusion Health care providers should continue to be aware of spousal deployment as a military-unique stressor in this population and rigorously screen for potential symptoms of postpartum depression, especially among those whose husbands are absent at delivery.

Keywords Postpartum depression · Women's health · Military deployment · Mental health

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J. A. Levine (✉) · A. T. Bukowinski · C. J. Sevick · A. M. S. Conlin
Deployment Health Research Department, Naval Health Research Center, 140 Sylvester Road, San Diego, CA 92106-3521, USA
e-mail: jordan.levine@med.navy.mil

K. M. Mehlhaff
Wright-Patterson Air Force Base, Dayton, OH 45433, USA

Introduction

Postpartum depression is a psychological affliction affecting 10–15 % of U.S. women [1] that can have negative consequences for the mother, father, and child. Mothers suffering from postpartum depression are at risk for substance abuse, future mood disorders, suicide, infant abuse, and infanticide [2–4]. The condition may also compromise marital welfare as a result of maternal emotional instability and erratic behavior, and leave the husband more susceptible to depression [2]. Furthermore, postpartum depression may interfere with mother–child bonding in the first year of life and consequently impede infant cognitive growth [2, 3].

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Prior research has shown infants of depressed mothers suffer delayed social and neurological maturity when compared with infants of non-depressed mothers [5], which can lead to poor emotional developmental outcomes throughout childhood [2]. Several risk factors have been shown to increase the odds of postpartum depression, the strongest of which include stressful life events and lack of social or marital support [6–10]. Other confirmed predictors include existing depression or anxiety, substance use in pregnancy, and adverse obstetric outcomes [6–11]. Demographic factors such as socioeconomic status, race/ethnicity, and maternal age may also affect postpartum depression, but conclusive evidence remains tenuous at this point [6–9, 12, 13].

Because military deployment is a stressful life event that disrupts customary marital support systems, wives of military members deployed during their child's gestation, delivery, or first year of life may be especially vulnerable to postpartum depression and other psychological afflictions [14]. As the military operations in Iraq and Afghanistan come to a close, it is imperative to assess the effects of deployment on military families to ensure their continued health and well-being [15, 16]. Accordingly, the proper mental health surveillance of military wives remains an integral component of preserving the welfare of military families, which in turn strengthens the readiness of the U.S. Armed Forces community as a whole [17, 18].

Prior research has demonstrated an association between spousal deployment and postpartum depression among military wives [19, 20], but several aspects of this relationship warrant further exploration. Depression screening scores or self-reports have often been used as a proxy for medical diagnosis, which may not accurately reflect postpartum depression prevalence in this population. Furthermore, screening for postpartum depression typically occurs at the traditional 6-week postpartum medical appointment, which would not capture depression that manifests thereafter. Finally, while deployment length itself has been assessed, the timing of deployment in relation to pregnancy and delivery has not been thoroughly considered.

The aim of this study was to use objective measures of depression and deployment to investigate this relationship in a large-scale military setting over time, utilizing the Department of Defense Birth and Infant Health Registry (Registry) and military personnel records to do so. The Registry allows for the continued reproductive health surveillance of military members and their families and is thus a useful tool in assessing depression as it relates to spousal deployment in pregnancy and the postpartum period.

Materials and methods

Population

This retrospective cohort study utilized information from the Registry, which was established in 1998 at the Naval Health Research Center in San Diego, CA, to identify infants born to Department of Defense beneficiaries and follow them throughout the first year of life [21]. The Registry compiles health information related to pregnancy, delivery, and infancy from the Military Health System Data Repository, creating a database of electronic records of medical encounters at both military and civilian treatment facilities. These records use International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes to track medical diagnoses, procedures, and examinations. Once data are obtained from the Repository, validation checks are conducted to ensure accuracy and consistency. A percentage of hard-copy medical records are compared with corresponding electronic records to confirm that the Registry data accurately reflect patient health information.

In order to define the population of mothers for the study, singleton infants in the Registry born to dependent wives of active-duty U.S. military service members between 2004 and 2009 were identified. Women with multiple pregnancies during this time were included for each of their pregnancies if all other inclusion criteria were met. Defense Enrollment Eligibility Reporting System files were used to identify mothers who were enrolled in the Department of Defense health care program in the year preceding and the year following the infant's birth, and who remained married to the same military sponsor throughout this 2-year period.

A number of exclusion criteria were defined based on medical and enrollment records. Because thyroid disease can manifest as depression-like illness, women with an ICD-9-CM-coded diagnosis of thyroid disorder (240.xx–246.xx), thyroid cancer (193), or personal history of thyroid cancer (V10.87) in the year preceding or following delivery were excluded from the study for that particular pregnancy. Women with no record of care between 8 weeks and 1 year postpartum were also excluded for that particular pregnancy due to lack of visibility. Finally, women with prior military service were excluded from analyses, under the assumption that they would be more familiar with the deployment process and, therefore, experience spousal deployment differently than would women with no prior military service (Online Resource 1).

This research was conducted in compliance with all applicable federal regulations governing the protection of human subjects in research. Institutional review board approval was obtained from the Naval Health Research

Center (protocol NHRC.2007.0002); informed consent was waived in accordance with criteria set forth by 32 CFR 219.

Variables of interest

Primary exposure

Deployment data were obtained from electronic personnel records provided by the Defense Manpower Data Center Contingency Tracking System. These records include beginning and end dates for each service member's deployments in support of the military operations in Iraq and Afghanistan. Spousal deployments were classified by their timing in relation to the wife's estimated date of conception and infant's date of birth. Estimated date of conception was calculated as the infant's date of birth minus his or her estimated gestational age (EGA) at delivery (to approximate the mother's first day of the last menstrual period) plus 14 days. Husbands who deployed after their wife's estimated date of conception and returned on or before the delivery date were classified as "deployed before delivery." Husbands who were deployed between conception and delivery, and returned after delivery, were classified as "deployed during delivery." Last, husbands who were deployed on or after the delivery date, but before 6 months postpartum, were classified as "deployed after delivery" (Fig. 1). The 6-month cutoff for this category was implemented to allow time for diagnosis of depression before the infant's first birthday, which signifies the end of the postpartum period in this study. Pregnancies in which the wife's estimated date of conception occurred during her husband's deployment were not included in analyses. In order to account for husbands who were deployed at multiple time points relative to delivery, deployment categories were not made mutually exclusive.

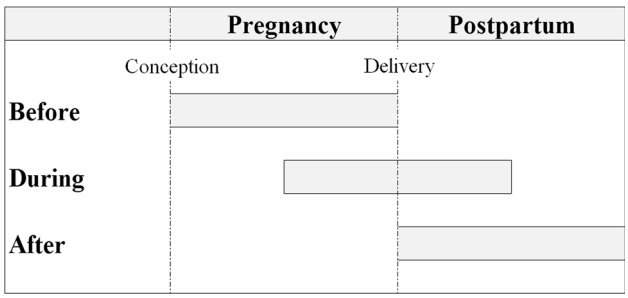

Fig. 1 Spousal deployment timing categories: Before, husband deployed and returned before the delivery date; During, husband deployed before but returned after the delivery date; After, husband deployed after the delivery date (but before 6 months postpartum to allow for follow-up time)

Outcome

Postpartum depression among military wives was identified through ICD-9-CM codes in maternal medical records (296.2x, 296.3x, 296.82, 298.0, 300.4, 301.12, 309.0, 309.1, 309.28, 311, 648.4x) [22–24]. The 648.4x code, defined as "mental disorders complicating pregnancy, childbirth, or the puerperium," can be used to indicate postpartum depression diagnosis, but is classifiable to a number of additional mental health codes. For the purposes of this study, 648.4x was considered a postpartum depression diagnosis if no other mental health disorders to which the code is classifiable (290–303, 305.0, 305.2–305.9, 306–316, and 317–319) were diagnosed during the postpartum period. Although the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, specifies that depressive symptoms must manifest within 4 weeks postpartum, there remains considerable disagreement within the medical community on this timing stipulation [3, 25]. Many care providers diagnose postpartum depression up to 6 months or 1 year following delivery [3, 26, 27]. Accordingly, the definition of "postpartum" in this study spans from the day after delivery through the infant's first birthday. If a mother received a depression diagnosis on her delivery record, but never in the year preceding or following delivery, she was excluded for that particular pregnancy due to the ambiguity of the diagnosis.

Covariates

Covariates assessed in this study consisted of standard demographic variables and additional factors shown to be relevant in existing literature [6–13, 24, 28, 29], including maternal age, mental health, and behavior; spousal demographics; and infant characteristics. Maternal age at delivery was ascertained through enrollment files and classified as younger than 20, 20–24, 25–29, 30–34, and 35 years and older. Maternal depression or anxiety diagnosed in the year preceding delivery was identified through ICD-9-CM codes in medical records (depression: 296.2x, 296.3x, 296.82, 298.0, 300.4, 301.12, 309.0, 309.1, 309.28, 311, 648.4x; anxiety: 300.0x, 308.0, 309.21, 309.24). Similar to the aforementioned postpartum depression diagnosis criteria, 648.4x was considered a depression or anxiety diagnosis only if no other mental health disorders to which the code is classifiable were diagnosed in the year preceding delivery. Maternal behavior covariates were also assessed via ICD-9-CM codes and included alcohol (303.x[0–2], 305.0[0–2]), drug (304.x[0–2], 305.2[0–2]–305.8[0–2], 648.3x, 655.5x) and tobacco use disorder (305.1[0–2], 649.0x,) diagnosed in pregnancy.

Spousal demographics were obtained from military personnel files and used in place of certain maternal demographics that are not available through Registry data. These included race/ethnicity (white non-Hispanic, black non-Hispanic, Hispanic, other/unknown) and rank (enlisted, officer), which is a proxy for socioeconomic status. Other variables included military service branch (Army, Air Force, Marine Corps, Navy) and occupation (combat specialist, health care, other). Spousal education was not included in analyses due to its collinearity with military rank.

Infant covariates evaluated in analyses included preterm birth, birth defects diagnosed through the first year of life, and gender. Preterm birth was assessed using each infant's EGA at delivery. EGA was derived from ICD-9-CM codes on both the infant birth record (weeks of gestation: 765.2x; preterm birth: 765.0x, 765.1x; postterm birth: 766.x) and the maternal delivery record (preterm delivery: 644.2x; postterm pregnancy: 645.1x, 645.2x). Newborns delivered at an EGA of less than 37 completed weeks were considered preterm. Birth defects were identified in accordance with the National Birth Defects Prevention Network case definition [30], which uses ICD-9-CM codes for congenital anomalies (740.xx–760.xx). Per the Metropolitan Atlanta Congenital Defects Program guidelines [31], cases of atrial septal defect (745.5x) and patent ductus arteriosus (747.0x) in preterm infants were not included in this definition. Gender was ascertained from enrollment records.

Statistical analysis

Univariable analyses, including descriptive statistics and Chi-square testing, were used to describe the distribution of the study population with respect to spousal deployment and all covariates of interest. Multivariable logistic regression models were utilized to estimate odds ratios and 95 % confidence intervals for postpartum depression among dependent military mothers. All models were adjusted for the aforementioned maternal, spousal, and infant covariates, and exposure variables were mutually adjusted for one another. Statistical interactions between exposure variables and covariates were also assessed. To account for simultaneous estimation of odds ratios for the three exposure variables, a Bonferroni correction was implemented, and statistical significance for these variables was established at $P < 0.0167$ $(0.05 \div 3)$. Statistical significance of all other variables was established at $P < 0.05$.

Regression diagnostics were used to screen for confounding and multicollinearity among variables. Confounding variables were defined as those that led to a 10 % or greater change in odds ratio between exposure and outcome. Multicollinearity was determined using a variance inflation factor of 4.0 or higher. Model goodness-of-fit was assessed via Pearson and deviance statistics. Generalized estimating equations were used to assess the possible effects of correlation of outcomes among mothers with more than one pregnancy in the dataset.

To ensure that cumulative time deployed did not bias study results, sub-analyses suggested by the data evaluated the effect of total deployment length [23, 32] on postpartum depression among women whose husbands deployed exclusively during delivery. The cumulative number of days each husband was deployed between his wife's estimated date of conception and the infant's first birthday was computed, and ongoing deployments were right-truncated at this point. Deployment length was analyzed both continuously and categorically (0–90, 91–180, 181–360, and 361+ days). Models included all covariates adjusted for in the primary analyses.

Post hoc power analyses, using a Bonferroni-adjusted α of 0.0167 and the observed outcome prevalence in the unexposed groups, demonstrated that this study has at least 80 % power to detect odds ratios of 1.10 or higher with three simultaneous exposure variables. All statistical analyses were performed using SAS software, version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 161,454 pregnancies between 2004 and 2009 were identified for this study. In this time frame, 43,379 women (26.9 %) experienced spousal deployment at some stage in their pregnancy or postpartum period. Of the husbands who deployed, 9977 (23.0 %) departed and returned before delivery; 15,527 (35.8 %) departed before and returned after delivery; and 20,245 (46.7 %) departed in the 6 months following delivery. These non-mutually exclusive timing categories include 2353 husbands (5.4 %) who deployed at multiple time points relative to their child's birth.

Table 1 shows the prevalence of model covariate characteristics as they relate to spousal deployment. Military wives of those who were deployed at any point between the estimated date of conception and 6 months postpartum were more likely to suffer from antepartum depression/anxiety (15.0 vs 13.4 %; $P < 0.001$) and use tobacco in pregnancy (5.3 vs 3.7 %; $P < 0.001$) than were those whose husbands did not deploy. Husbands who were deployed at any point during this period were proportionally more likely to be enlisted (79.4 vs 75.3 %; $P < 0.001$) and in the Army (48.6 vs 28.8 %; $P < 0.001$) compared with those who were not deployed. The prevalence of postpartum depression among military wives whose husbands were deployed at any point in this period was 17.6 %, compared with 15.7 % among those whose husbands did

Table 1 Prevalence of postpartum depression and maternal, spousal, and infant covariates, by spousal deployment status, 2004–2009

Characteristic	Deployed at all		Deployed before delivery		Deployed during delivery		Deployed after delivery		Total
	No *N* (%)	Yes *N* (%)	No *N* (Col %)	Yes *N* (Col %)	No *N* (Col %)	Yes *N* (Col %)	No *N* (Col %)	Yes *N* (Col %)	*N* (%)
Total	118,075 (73.1)	43,379 (26.9)	151,447	9977	145,927	15,527	141,209	20,245	161,454
Postpartum depression									
No	99,490 (84.3)	35,756 (82.4)	126,914 (83.8)	8332 (83.5)	122,581 (84.0)	12,665 (81.6)	118,494 (83.9)	16,752 (82.7)	135,246 (83.8)
Yes	18,585 (15.7)	7623 (17.6)	24,563 (16.2)	1645 (16.5)	23,346 (16.0)	2862 (18.4)	22,715 (16.1)	3493 (17.3)	26,208 (16.2)
Maternal age at delivery									
<20	1404 (1.2)	944 (2.2)	2194 (1.4)	154 (1.5)	1905 (1.3)	443 (2.8)	1962 (1.4)	386 (1.9)	2348 (1.4)
20–24	32,197 (27.3)	15,063 (34.7)	44,327 (29.2)	2933 (29.4)	41,244 (28.3)	6016 (38.7)	40,536 (28.7)	6724 (33.2)	47,260 (29.3)
25–29	43,509 (36.8)	15,218 (35.1)	55,072 (36.4)	3655 (36.6)	53,546 (36.7)	5181 (33.4)	51,445 (36.4)	7282 (36.0)	58,727 (36.4)
30–34	28,116 (23.8)	8698 (20.0)	34,484 (22.8)	2330 (23.4)	34,055 (23.3)	2759 (17.8)	32,624 (23.1)	4190 (20.7)	36,814 (22.8)
≥35	12,849 (10.9)	3456 (8.0)	15,400 (10.2)	905 (9.1)	15,177 (10.4)	1128 (7.3)	14,642 (10.4)	1663 (8.2)	16,305 (10.1)
Antepartum depression or anxiety									
No	102,214 (86.6)	36,853 (85.0)	130,463 (86.1)	8604 (86.2)	126,001 (86.4)	13,066 (84.1)	121,834 (86.3)	17,233 (85.1)	139,067 (86.1)
Yes	15,861 (13.4)	6526 (15.0)	21,014 (13.9)	1373 (13.8)	19,926 (13.6)	2461 (15.9)	19,375 (13.7)	3012 (14.9)	22,387 (13.9)
Alcohol use in pregnancy									
No	117,915 (99.9)	43,304 (99.8)	151,253 (99.8)	9966 (99.9)	145,725 (99.9)	15,494 (99.8)	141,007 (99.9)	20,212 (99.8)	161,219 (99.8)
Yes	160 (0.1)	75 (0.2)	224 (0.2)	11 (0.1)	202 (0.1)	33 (0.2)	202 (0.1)	33 (0.2)	235 (0.2)
Drug use in pregnancy									
No	117,216 (99.3)	43,062 (99.3)	150,367 (99.3)	9911 (99.3)	144,867 (99.3)	15,411 (99.2)	140,185 (99.3)	20,093 (99.2)	160,278 (99.3)
Yes	859 (0.7)	317 (0.7)	1110 (0.7)	66 (0.7)	1060 (0.7)	116 (0.8)	1024 (0.7)	152 (0.8)	1176 (0.7)
Tobacco use in pregnancy									
No	113,731 (96.3)	41,080 (94.7)	145,165 (95.8)	9646 (96.7)	140,274 (96.1)	14,537 (93.6)	135,622 (96.0)	19,189 (94.8)	154,811 (95.9)
Yes	4344 (3.7)	2299 (5.3)	6312 (4.2)	331 (3.3)	5653 (3.9)	990 (6.4)	5587 (4.0)	1056 (5.2)	6643 (4.1)
Spousal race/ethnicity									
White non-Hispanic	81,637 (69.2)	29,966 (69.1)	104,220 (68.8)	7383 (74.0)	101,382 (69.5)	10,221 (65.8)	97,399 (69.0)	14,204 (70.2)	111,603 (69.1)
Black non-Hispanic	13,495 (11.4)	5067 (11.7)	17,684 (11.7)	878 (8.8)	16,513 (11.3)	2049 (13.2)	16,254 (11.5)	2308 (11.4)	18,562 (11.5)
Hispanic	13,015 (11.0)	5141 (11.8)	17,189 (11.3)	967 (9.7)	16,029 (11.0)	2127 (13.7)	15,903 (11.3)	2253 (11.1)	18,156 (11.3)
Other/unknown	9928 (8.4)	3205 (7.4)	12,384 (8.2)	749 (7.5)	12,003 (8.2)	1130 (7.3)	11,653 (8.2)	1480 (7.3)	13,133 (8.1)
Spousal military rank									
Enlisted	88,925 (75.3)	34,460 (79.4)	116,151 (76.7)	7234 (72.5)	110,330 (75.6)	13,055 (84.1)	107,683 (76.3)	15,702 (77.6)	123,385 (76.4)
Officer	29,150 (24.7)	8919 (20.6)	35,326 (23.3)	2743 (27.5)	35,597 (24.4)	2472 (15.9)	33,526 (23.7)	4543 (22.4)	38,069 (23.6)
Spousal military service									
Army	33,960 (28.8)	21,073 (48.6)	52,739 (34.8)	2294 (23.0)	45,263 (31.0)	9770 (62.9)	44,973 (31.8)	10,060 (49.7)	55,033 (34.1)
Air force	35,948 (30.4)	9714 (22.4)	41,219 (27.2)	4443 (44.5)	44,385 (30.4)	1277 (8.2)	40,817 (28.9)	4845 (23.9)	45,662 (28.3)
Marine corps	16,326 (13.8)	5775 (13.3)	20,792 (13.7)	1309 (13.1)	19,710 (13.5)	2391 (15.4)	19,855 (14.1)	2246 (11.1)	22,101 (13.7)

Table 1 continued

Characteristic	Deployed at all		Deployed before delivery		Deployed during delivery		Deployed after delivery		Total
	No *N* (%)	Yes *N* (%)	No *N* (Col %)	Yes *N* (Col %)	No *N* (Col %)	Yes *N* (Col %)	No *N* (Col %)	Yes *N* (Col %)	*N* (%)
Navy	31,841 (27.0)	6817 (15.7)	36,727 (24.3)	1931 (19.4)	36,569 (25.1)	2089 (13.5)	35,564 (25.2)	3094 (15.3)	38,658 (23.9)
Spousal occupation category									
Combat specialist	26,747 (22.6)	13,981 (32.2)	37,261 (24.6)	3467 (34.7)	35,683 (24.5)	5045 (32.5)	34,135 (24.2)	6593 (32.6)	40,728 (25.2)
Health care	8730 (7.4)	1989 (4.6)	10,373 (6.8)	346 (3.5)	9923 (6.8)	796 (5.1)	9797 (6.9)	922 (4.5)	10,719 (6.6)
Other	82,598 (70.0)	27,409 (63.2)	103,843 (68.6)	664 (61.8)	100,321 (68.7)	9686 (62.4)	97,277 (68.9)	12,730 (62.9)	110,007 (68.2)
Infant preterm birth									
No	108,407 (91.8)	40,219 (92.7)	139,258 (92.0)	9368 (93.9)	134,283 (92.0)	14,343 (924)	129,900 (92.0)	18,726 (92.5)	148,626 (92.0)
Yes	9668 (8.2)	3160 (7.3)	12,219 (8.0)	609 (6.1)	11,644 (8.0)	1184 (7.6)	11,309 (8.0)	1519 (7.5)	12,828 (8.0)
Infant birth defect									
No	113,663 (96.3)	41,872 (96.5)	145,928 (96.3)	9607 (96.3)	140,532 (96.3)	15,003 (96.6)	135,982 (96.3)	19,553 (96.6)	155,535 (96.3)
Yes	4412 (3.7)	1507 (3.5)	5549 (3.7)	370 (3.7)	5395 (3.7)	524 (3.4)	5227 (3.7)	692 (3.4)	5919 (3.7)
Infant gender									
Female	57,319 (48.5)	21,192 (48.8)	73,575 (48.6)	4936 (49.5)	70,923 (48.6)	7588 (48.9)	68,643 (48.6)	9868 (48.7)	78,511 (48.6)
Male	60,756 (51.5)	22,187 (51.2)	77,902 (51.4)	5041 (50.5)	75,004 (51.4)	7939 (51.1)	72,566 (51.4)	10,377 (51.3)	82,943 (51.4)

not deploy ($P < 0.001$). With regard to deployment timing, women whose husbands were deployed during delivery had the highest prevalence of postpartum depression (18.4 %), followed by those whose husbands were deployed after (17.3 %) and before (16.5 %) delivery.

Table 2 displays the results of the adjusted logistic regression model. After controlling for all maternal, spousal, and infant covariates, a modest statistically significant increase in the odds of postpartum depression was detected for wives whose husbands were deployed during delivery compared to those whose husbands were not deployed during delivery [odds ratio (OR) 1.10, 95 % confidence interval (CI) 1.04–1.15; $P < 0.0001$]. The odds of postpartum depression were not statistically significant for either those whose husbands were deployed before ($P = 0.0488$) or after ($P = 0.3248$) delivery at the Bonferroni-adjusted significance level. Other factors found to increase the odds of postpartum depression included younger maternal age (less than 25 years at delivery); antepartum depression/anxiety; alcohol, drug, or tobacco use in pregnancy; marriage to a spouse who is white non-Hispanic, in the Army, or enlisted; and delivery of a child prematurely or with a birth defect.

An interactive effect between spousal deployment during delivery and antepartum depression/anxiety was detected in the data ($P < 0.001$). For wives without an antepartum depression/anxiety diagnosis, spousal deployment during delivery was associated with increased odds of postpartum depression (OR 1.13, 95 % CI 1.07–1.20). Conversely, for wives with an antepartum depression/anxiety diagnosis, a decreased odds of postpartum depression was observed (OR 0.87, 95 % CI 0.80–0.95).

The deployment length sub-analyses for those whose husbands were deployed exclusively during delivery ($n = 15{,}036$) did not yield significant results. After adjusting for the same covariates as in the original model, and assessing deployment length both continuously and categorically, increasing deployment length was not associated with an increased odds of postpartum depression ($P = 0.6131$ for continuous model, $P = 0.7752$ for categorical model). All models demonstrated a good fit and did not reveal confounding factors or correlation among outcomes.

Discussion

Study results

This study is unique in its ability to objectively evaluate the timing of spousal deployment as it relates to

Table 2 Adjusted odds ratios of postpartum depression among military wives, by spousal deployment status, 2004–2009

Characteristic	Total	Postpartum depression (%)	OR (95 % CI)[a]	*P* value[b]
Total	161,454	26,208 (16.23)		
Deployed before delivery				
No	151,477	24,563 (16.22)	Reference	0.0488
Yes	9977	1645 (16.49)	1.06 (1.00–1.13)	
Deployed during delivery				
No	145,927	23,346 (16.00)	Reference	<0.0001
Yes	15,527	2862 (18.43)	1.10 (1.04–1.15)[c]	
Deployed after delivery				
No	141,209	22,715 (16.09)	Reference	0.3248
Yes	20,245	3493 (17.25)	1.02 (0.98–1.07)	
Maternal age at delivery				
<20	2348	473 (20.14)	1.19 (1.06–1.33)	<0.0001
20–24	47,260	8665 (18.33)	1.09 (1.05–1.13)	
25–29	58,727	9340 (15.90)	Reference	
30–34	36,814	5439 (14.77)	0.99 (0.95–1.03)	
≥35	16,305	2291 (14.05)	0.95 (0.90–1.00)	
Antepartum depression or anxiety				
No	139,067	15,657 (11.26)	Reference	<0.0001
Yes	22,387	10,551 (47.13)	6.40 (6.20–6.61)	
Alcohol use in pregnancy				
No	161,219	26,100 (16.19)	Reference	0.0058
Yes	235	108 (45.96)	1.51 (1.13–2.02)	
Drug use in pregnancy				
No	160,278	25,729 (16.05)	Reference	<0.0001
Yes	1176	479 (40.73)	1.88 (1.65–2.15)	
Tobacco use in pregnancy				
No	154,811	23,979 (15.49)	Reference	<0.0001
Yes	6643	2229 (33.55)	1.47 (1.39–1.57)	
Spousal race/ethnicity				
White non-Hispanic	111,603	20,033 (17.95)	Reference	<0.0001
Black non-Hispanic	18,562	2188 (11.79)	0.61 (0.58–0.64)	
Hispanic	18,156	2447 (13.48)	0.71 (0.68–0.74)	
Other/unknown	13,133	1540 (11.73)	0.67 (0.63–0.71)	
Spousal military rank				
Enlisted	123,385	21,759 (17.64)	Reference	<0.0001
Officer	38,069	4449 (11.69)	0.69 (0.66–0.71)	
Spousal military service				
Army	55,033	9954 (18.09)	Reference	<0.0001
Air Force	45,662	6743 (14.77)	0.84 (0.81–0.87)	
Marine Corps	22,101	3547 (16.05)	0.86 (0.82–0.90)	
Navy	38,658	5964 (15.43)	0.89 (0.86–0.93)	
Infant preterm birth				
No	148,626	23,548 (15.84)	Reference	<0.0001
Yes	12,828	2660 (20.74)	1.24 (1.18–1.30)	
Infant birth defect				
No	155,535	25,086 (16.13)	Reference	<0.0001
Yes	5919	1122 (18.96)	1.17 (1.09–1.25)	

CI confidence interval, *OR* odds ratio

[a] This model was also adjusted for spousal occupation (combat specialist, health care, other) and infant gender, neither of which yielded statistically significant results

[b] For the three deployment exposure variables, statistical significance was established at $P < 0.0167$. For all other variables, statistical significance was established at $P < 0.05$

[c] For those without a preexisting antepartum depression/anxiety diagnosis, OR 1.13 (1.07–1.20); for those with a diagnosis, OR 0.87 (0.80–0.95)

postpartum depression diagnosis in military wives. The odds of postpartum depression among women whose husbands were deployed before and returned after delivery (i.e., deployed during delivery) were slightly higher compared to women whose husbands were not deployed at this time. Although the effect size of this relationship is admittedly small, its statistical significance suggests that the emotional fragility of the period immediately preceding and following delivery may be exacerbated by the absence of a spouse. After adjusting for multiple exposures via a Bonferroni correction, no statistically significant relationship was detected for women whose husbands were deployed and returned before the delivery date, or for women whose husbands were deployed after the delivery date.

The sub-analyses in this study indicate that the timing of the spousal deployment relative to delivery date, rather than the length of the deployment itself, is associated with postpartum depression. This conclusion regarding deployment timing is similar to that of a previous study by Robrecht et al. [19] showing that women whose husbands were deployed during pregnancy, but not in the postpartum period, were more likely to screen positive for depression compared to women whose husbands were not deployed in that period. However, a different study by Mansfield et al. [23] showed an incremental positive relationship between spousal deployment length and risk of postpartum depression among military wives, the results of which were not replicated here. These discrepancies indicate the need for further research on this topic.

The relationship between deployment and postpartum depression did not prove universally perilous among those whose husbands were deployed during delivery. Spousal deployment during this time was unexpectedly shown to be protective in military wives who experienced antepartum depression or anxiety. While both of these factors independently increase the odds of postpartum depression, it is plausible that the protective association detected in this study is attributable to increased awareness and medical care utilization among women with existing mental health diagnoses. Perhaps those whose husbands went on to be deployed during delivery may have been more proactive in seeking treatment or support services in anticipation of the impending deployment, and as such, were less likely to receive a postpartum diagnosis. Nevertheless, this phenomenon may serve as the impetus for additional research regarding the relationship between preexisting mental health conditions and imminent spousal deployment in military populations.

Strengths and limitations

The strengths of this study lie in its use of a large and diverse military sample, retrospective cohort study design with complete data, and rigorous case definition that identifies temporal risk factors for postpartum depression in dependent military women. Past research efforts have established the fundamental principles for this field of study, but many possess limited generalizability based on their small or homogenous samples [14, 19, 33]. This study population included wives of active-duty military members from each of the four service branches, various occupation categories, and different ranks, to capture the diversity in the military personnel and deployment experiences. A number of previous studies have used depression scales as a proxy for diagnosis, which only indicates that a woman screens positive for depression and merits additional evaluation [19, 20, 33, 34]. Furthermore, depression screening often takes place only at the standard 6-week postpartum medical appointment, which would not capture depressive symptoms that arise thereafter [19, 20, 33]. This study utilizes a complex algorithm that identified women with clinically diagnosed depression based on ICD-9-CM codes assigned throughout the entire first postpartum year. Finally, the timing of deployment in relation to delivery has not been sufficiently explored [34]. Certain studies have examined deployment length as it relates to postpartum depression, but have not considered the temporality of that deployment [23]. Accordingly, gaps in existing literature highlight the need for a large-scale study of postpartum depression diagnosis in military wives whose husbands were deployed during pregnancy, delivery, and/or the postpartum period [35].

There are several limitations of this study based on the available data. Although military personnel files include information on rank, occupation, and service branch, these variables may not accurately assess the specific challenges associated with a given deployment experience. Moreover, these files were not linked to military member medical care during and following deployment. Because of this, potential physical and psychological afflictions incurred during deployment were not analyzed, despite their plausibility for compromising domestic welfare.

The use of medical records and ICD-9-CM codes for diagnoses posed additional challenges in this study. Unlike self-reported measures, medical data are unable to indicate certain potential risk factors for postpartum depression in this population, such as perception of social support and past experience with spousal deployment. Also, as certain medical information is ascertained from the patient–clinician interaction, it carries with it the potential for underreporting sensitive health and behavioral matters such as substance abuse and mental health conditions. Furthermore, even if these matters are discussed, they may not be properly coded in medical records. Finally, there currently exists no ICD-9-CM code that diagnoses postpartum depression specifically. As such, the condition may be coded

a variety of ways, depending on the preference of the coder. The ICD-9-CM codebook index lists 648.4 as the primary postpartum depression diagnosis code, but because this code is classifiable to a number of other postpartum conditions, it may lead to the misclassification of certain women. Correction for this potential bias was implemented through the use of a rigorous algorithm separating those with a 648.4 code for postpartum depression from those with the same code for a different condition.

Because depression screening is likely not uniformly administered among practitioners [36–38], it is possible that certain women in this study met the clinical criteria for postpartum depression but remained undiagnosed. Because of this, they would be misclassified as non-depressed in this study, despite the visibility of their medical records throughout the first postpartum year. As this misclassification is likely unrelated to spousal deployment status, it is non-differential in nature and likely to bias results toward the null, which may explain the modesty of the observed association. Previous studies that have used screening scores for military-dependent women coping with spousal deployment have identified rates of postpartum depression between 5 and 31 % [19, 20, 34]. This wide range provides justification for a study utilizing a different outcome classification technique based on clinical diagnosis. Rates of postpartum depression in this study are higher in women facing spousal deployment than in those who are not, which is consistent with existing literature and thus supports the use of this classification approach.

Considerations and future directions

The data presented here support the continued allocation of resources to assist military wives facing spousal deployment and demonstrate the necessity of routine screening for postpartum depression in this population. Data on health trajectories following these screenings would also facilitate future research efforts. Information regarding the potential increased risk of postpartum depression in wives of deployed service members, especially those whose husbands are absent at delivery, may prompt health care providers to identify these patients for more rigorous screening and early intervention. The benefits of such preventive measures and assistance programs likely outweigh the costs of their implementation and the potential repercussions for the affected families.

In a community where stoicism regarding familial challenges, such as spousal deployment, is highly valued, military wives may be reluctant to report existing symptoms to their providers. In addition to increased screening, practitioners might consider simply asking each patient if her husband is or will soon be deployed. The mere acknowledgment of the difficult situation facing these women will likely strengthen their relationship with their provider, which could, in turn, prompt patients to be more forthcoming about existing symptoms so that depression can be diagnosed and treated sooner. Furthermore, if women have a safe environment in which to share mental health concerns, they may be more likely to encourage their husbands to seek similar care if needed. This open communication and willingness to pursue treatment may strengthen the family system, improve parent–child bonding, and protect against future mental health illness.

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Levine, Jordan A; Bukowinski, Anna T; Sevick, Carter J; Mehlhaff, Krista M.; Conlin, Ava Marie S

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Commanding Officer
Naval Health Research Center
140 Sylvester Rd
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Commanding Officer
Naval Medical Research Center
503 Robert Grant Ave
Silver Spring, MD 20910-7500

Chief, Bureau of Medicine and Surgery
7700 Arlington Blvd
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14. ABSTRACT

This retrospective cohort study was conducted to evaluate the association between spousal deployment and postpartum depression among pregnant wives of active-duty service members. Medical records for 161,454 births occurring between 2004 and 2009 were used to define postpartum depression and several medical and behavioral covariates. Military personnel files were used to define deployment and service-related covariates. Three non-mutually exclusive exposure variables were created to categorize deployments as occurring before, during, or after the infant's delivery.

Spousal deployment in pregnancy with return after delivery (ie, deployment during delivery) was significantly associated with postpartum depression (odds ratio [OR] 1.10, 95% confidence interval [CI] 1.04–1.15). An interactive effect between preexisting depression or anxiety and deployment during delivery was also detected in the data: OR 1.13, 95% CI 1.07–1.20 for those without a preexisting diagnosis; OR 0.87, 95% CI 0.80–0.95 for those with a preexisting diagnosis.

Health care providers should continue to be aware of spousal deployment as a military-unique stressor in this population and monitor for potential symptoms of postpartum depression, especially among those whose husbands are deployed during delivery. Support services and resources should be provided accordingly.

15. SUBJECT TERMS
postpartum depression, military wives, military families, deployment, ICD-9-CM, mental, infants

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